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Dr. Joseph H. Bredekamp  
Senior Science Program Executive/Information Systems  
Heliophysics Division  
Science Mission Directorate  
NASA Headquarters  
Washington, DC 20546-0001

Dear Dr. Bredekamp,

**RE: First year report and request for renewal of NASA AISRP grant NNX08AD19G:  
Visualization of Terascale Datasets with Impostors**

Principle Investigator: Thomas Quinn

Co-Investigator: Laxmikant V. Kale

Co-Investigator: Orion Sky Lawlor

During the past year the investigators began their collaboration on developing innovative techniques for visualization and analysis of large datasets. This work is building on previous work that the participants have done together. Specific implementations are being built on top of our existing simulation, analysis and visualization frameworks, partially funded by a previous AISR grant. Planning and coordination of this effort was expedited by a couple of in-person meetings among the investigators.

As described in our proposal work schedule, we began by implementing and testing parallel data compression techniques on our 2D images. In particular, we have added JPEG image compression to the lower levels of the network image transport protocol used by our visualization tool. Over a low-bandwidth, high latency network, this alone substantially improves achievable performance. For example, testing on a wireless network shows that we can get a factor of 3 or so increase in framerate over our previous implementation.

At the University of Washington, Quinn oversaw a graduate student, Rok Roskar, who incorporated LiveViz, the visualization framework previously developed by Lawlor, into our massively parallel gravity code, ChaNGa. This is the first step in achieving the goal of interactively visualizing a large simulation as it is running. Currently, only a fixed viewpoint

is displayed. This in itself is quite helpful for quickly diagnosing a simulation, but we plan to add the capability of interactively manipulating the view as the simulation continues to run.

At the University of Illinois, Kale is overseeing a graduate student, Lukasz Wesolowski, who has been working on visualization-related issues. First, Lukasz worked on GPGPU's, exploring their applicability for the execution of message-driven parallel programming paradigms such as Charm++; this study has been incorporated in his master's thesis. Next, interacting with Prof. Lawlor, he started to measure the performance of some visualization benchmarks that involve intensive inter-processor communication. Those benchmarks included the JPEG image compression scheme, and utilize the CCS protocol, which is built into the Charm++ infrastructure developed at Illinois. Through the CCS protocol, it is possible for clients to connect and receive data directly from the processors running a parallel application. Lukasz is currently studying the achievable frame-rates that one can obtain, as a function of (a) the number of server CPU's used, (b) problem/scene size, and (c) display size.

In February, Quinn traveled to University of Alaska Fairbanks in part to confer with Lawlor on planning for the work in this grant. This included demonstrations of the visualization techniques that Lawlor has been working on, and a discussion of their applicability to scientific datasets. In May, Quinn traveled to UIUC to attend the CHARM++ workshop. As well as presenting at the workshop, Quinn, Kale, and the personnel under Kale's supervision conferred on work progress and plans. Lawlor also traveled to UIUC to collaborate with graduate students on the JPEG image compression work. In order to more continuously keep each other up to date, and to coordinate work efforts, the participants in this work have conferenced bi-weekly via telephone throughout the year.

In the coming year we will both incorporate some of the outcomes of this years development into our production codes, and continue to develop more advanced visualization techniques. The JPEG image compression will be integrated into our Salsa parallel visualization framework. Work will also continue on making the on-the-fly visualization of large simulations more interactive, and therefore, more useful. We will also be experimenting with efficient compositing of 3D "volume impostors" on the parallel machine and transmitting them across the network.

In light of our progress, I request that this grant be renewed for a second year in the amount of \$233,345 for the period 11/30/08 to 11/29/09. The budget for spending this money is as given on the second year budget form submitted with the original proposal, with further details given in the subcontracts Appendix to that proposal.

Sincerely,

Thomas Quinn